INTELLECTUAL IMPLICATIONS OF MULTI-ACCESS COMPUTER NETWORKS

D. C. Engelbart, Stanford Research Institute

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ORGANISMS AND ORGANIZATIONS 2

I'll take an unlikely start and begin with dinosaurs. I have a six-year-old son who is tremendously impressed and intrigued with dinosaurs. We read and re-read all of the dinosaur books, and every time we go to the library we have to bring home new ones. 2a

Consider a dinosaur (with what little we know and much we may speculate) as a big, monstrous organism whose specialized organs cooperated reasonably well by the then-prevailing standards of "organism design", but whose function was coordinated by a clumsy, crude nervous system and a pitiful little brain. My image of this "clumsy nervous system" can be characterized by the story I've heard (or perhaps this is one that I've invented for six-year-old consumption, and now believe) about an embattled dinosaur not sensing for several minutes that it was dead. 2b

But yet apparently this was an organism marvelously fitted to its environment. The dinosaurs thrived for over 200 million years, as I remember from all those books, much longer than our race has been around. But suddenly -- suddenly in terms of geological time -- they disappeared. 2c

My learned deduction, derived from first-grade scientific literature, is that competition from better-designed nervous systems did them in: better sensors; better sensory-data analyzers (perception); better peripheral contingency decision making (reflexes); better coordination of the functioning of organs, muscles, etc.; better rational analyses of events and history; better accumulation of learned experience; better projection, visualization and planning, etc., etc. 2d

I want to fix in your minds an image of a biological organism that possessed formidable capability within the environment

into which it evolved, but which couldn't make the grade against the competition that a continuing evolution brought into that environment. 2e

Human organizations can be likened to biological organisms, and I find much value in considering the analogy. Organizations evolve too; their mutations are continually emerging and being tested for survival value within their environment. I happen to feel that evolution of their environment is beginning to threaten today's organizations, large and small -- finding them seriously deficient in their "nervous-system" design -- and that the degree of coordination, perception, rational adaptation, etc. which will appear in the next generation of human organizations will drive our present organizational forms, with their "clumsy nervous systems", into extinction. 2f

It is these "nervous-system" functions, within human organizations, where I find the most significant intellectual implications stemming from the forthcoming multi-access computer networks. 2g

AUGMENTATION SYSTEMS 3

For many years I have been developing a research program at Stanford Research Institute aimed at Augmenting the Human Intellect. By intellect I mean the human competence to make, send, exchange and apply to decision-making the commodity called knowledge, as applied toward giving human individuals and organizations more effectiveness at formulating and pursuing their goals. My basic formulation of such a pursuit considers a large system of things to be involved in being intellectual, and being successful at it. A rough but useful categorization of the system's components is as follows: 3a

Biologically Provided Human (BPH) capabilities are the basic components of this "large system" -- e.g., memory, visualization, learning and reasoning, as linked to the human's internal-external environment by sensory-perception and coordinate-motor I/O systems. 3a1

Culturally Provided (CP) items are also basic to this "large system": general things such as languages, methodologies, tools, and training; in specific forms such as algebra, schools, meetings, books, computers, maps and filing cabinets. Also, such items as the value structure, attitudes, motivations, etc. which are so important to the way an individual coordinates and directs his BPH

capabilities, may similarly be said to be "culturally provided". 3a2

An Effective Individual (EI) has a particular system of these CP items built atop his BPH capabilities. Our EI is like a little colony grown around the "raw-material" human, where in number and diversity of items this "ecology" of interdependent dynamics is as subtle and rich as what we are coming generally to appreciate in the "organic" world around us. 3a3

An Effective Organization (EO) is composed of a group of EI components, plus another particular set of CP items associated with their working together. 3a4

These CP items are all candidates for redesign, toward more effective individuals and organizations. To provide a new "augmentation system" for an individual, or especially for a group, is a very complex challenge. Just suppose, for instance, that a really new system had been developed, and consider the problem of checking out a group of people on their "new augmentation system" -- it would involve such as: teaching them new concepts and skills for representing and manipulating information; changing their working and collaborative methods; having them learn new roles and acquire associated new attitudes; changing the format and style for their formulating and communicating, etc. 3b

If the system is to represent a truly significant improvement, assume that the changes to which the new users must accommodate will pervade many levels and facets of the "way of doing their daily work", and that many of these changes will represent radical departures from their prior "ways". The people being given such a new system will have a rough period of learning and adaptation. People don't generally appreciate how many are the "little ways of doing things" that comprise our workaday world, that they may be subtly or radically changed, and that among them might appear a very different distribution of usage and importance. The EI and EO systems are more complex, but therefore richer, domains for development than is appreciated even (especially?) among the technologists in the computer and communication disciplines which have so much potential for changing those systems. 3c

My main message about Augmentation Systems is that, while indeed there are very challenging technical problems involved in supporting tomorrow's Effective Individuals and Organizations, the larger Augmentation System is much more

complex than the technological "subsystem" upon which it depends. We technologists aren't equipped to perceive this sort of thing, and those who are can't generally distinguish the Sunday-Supplement extrapolations from those more probable. It has been my business to struggle with these concepts for two decades now, and the signs that I read at least tell me that the changes in our ways of thinking and working will be more pervasive and extreme than ANY OF US appreciates -- a revolution like the development of writing and the printing press lumped together. The following notions represent some of the least fuzzy elements that I perceive. 3d

THE INTELLECTUAL WORKSHOP 4

In the context of this Conference, it is useful to talk about providing an individual with a "private intellectual work space" -- sort of what his office is supposed to be for him now. 4a

In using his office, an individual goes in, perhaps shuts his door, and spreads his current working information over his working surfaces. He keeps some local files there, does some thinking, some formulating and transmitting of messages to the outside, and receiving returning messages, etc. Some of these transmitted formulations are requisitions for things to be bought, made, commented upon, or etc. He sends them out and results will come back, usually in the form of information -- control feedback, substantive information from colleagues or support staff, etc. He digests, stores, reformulates, responds, and occasionally pursues reflective, creative thought. 4b

The image I'm trying to develop is of an office being the "intellectual workshop" in which one does his collaborative bit within his working environment: one needs work spaces, tools to suit a myriad of tasks, places to store working materials, aids to hold them for examination and shaping -- and they all should be easy to reach, quick to adjust to the task, easy to keep track of, etc. Interactive computer aids will have very significant effects here. 4c

This is the particular area that my group and I have been working on for some six years -- improving the individual's intellectual workshop -- as the first stage of exploring what augmentation might be like. By today's standards, we can demonstrate some impressive features in the workshop environment which we have created to test by our daily use (for doing our daily work). But by our own perspective, as

developed through constant struggle in this domain, we have but a primitive outpost on an unbelievably rich frontier. References 1 through 4 describe our work. I invite you to become acquainted, e.g., with Reference 1. Copies of the movie (Reference 2) are available; viewing this provides the best introduction to our "augmented office". 4d

It will take the explorers of this domain decades to even map its currently visible dimensions. The real rush hasn't begun: this Conference is a meeting of suppliers looking at the prospector trade; we haven't really been giving attention to the developments that will follow the prospecting. 4e

My research group is now moving into a next stage of work that we call "team augmentation". Here, instead of just the individual facilitating his private domain of searching, studying, thinking and formulating, as his office place provides for him, we are exploring what can be done for a team of "augmented individuals" who have in common a number of terminals, a set of computer tools, working files, etc. (as we do) to facilitate their team collaboration. 4f

Our major initial step toward augmenting a team is to facilitate the collaborative dialogue between its members, aiming for new kinds and degrees of collaboration that can thus be achieved. 4g

COLLABORATIVE DIALOGUE 5

To discuss our "Dialogue Support System", consider a shared-file space. This is a common enough thing in today's time-shared environment; but our dialogue-file space comprises "frozen" contributions from the collaborators -- i.e., it represents the "Journal" of transactional entries that make up the collaborative dialogue, entries that are part of the history of things and aren't to be changed. 5a

Assume that you are a participant in this dialogue, as from a CRT terminal in your office. You have just contributed some sort of entry into this Journal -- some tentative formulation of a plan or design. You expect some of your collaborators to be interested. You may have installed an "attention" signal at entry time, aimed at a particular set of people. At their consoles, they either receive an "annunciator" signal to alert them, or may have come across your entry via any number of natural pathways in the course of their work. 5b

These other people can very quickly and flexibly survey your

contribution. At any subsequent time, in any passage of your contribution, one of them can attach a "comment" to any specific entity (e.g., word, string of words, paragraph, drawing, line or label in the drawing). A comment can be one word (e.g., "Congratulations!"), or a reference to a contradictory passage, or a long exhortation about a better way to do the whole thing, other people will be attaching comments at other places, including comments upon other people's comments. What soon evolves from such activity is a network of contributions that represents a full-scale discourse, distributed over time and, if you wish, over space. 5c

A good "office-support system" will provide powerful aids to improve the effectiveness with which one can participate in such a dialogue. For example, one needs speed and flexibility in studying the consequent network of dialogue contributions and in filtering out that which is relevant -- for instance to make a successive version of a plan or design. We are evolving aids for: searching through specified sub-nets and selecting upon such attributes as content, previously assigned descriptive tags, authorship, absolute or relative "publishing" time, and citation linkages; assembling passages from the dialogue, and from one's own notes, with flexible disposition of one's screen into "windows" for independently viewing different materials; easily affixing new links and tags to arbitrary segments of a given memo; conveniently copying into one's own working file a categorized compilation of extracts, etc. 5d

One recognizes, of course, that the existing system of professional journals represents a similar mode of dialogue, distributed as it were over space and time. But the computer-aided dialogue has certain advantages to offer: interchanges in cycle times of minutes or seconds instead of years or months; accommodating more items, and items of much smaller size, without overloading the "clerical system"; accommodating more people making simultaneous accesses and contributions; providing citation followup to exact items (i.e., the computer can take you almost instantly to look at the particular item cited within another "document"). 5e

Within a team that has the kinds of tools and methods that are easily foreseeable, these features are really quite interesting and exciting to consider. We are planning to experiment with this type of collaboration in support of our own system-development activity, within our own shop. 5f

OFFICE-SHARING AND DIALOGUE IN THE ARPA NETWORK 6

Our Augmentation Research Center, at SRI, is a participating site in ARPA's experimental computer network (see References 5 and 6). My group is hoping that here the "augmented office" approach can be applied to a fuller advantage -- i.e., we hope to see researchers at other sites beginning to use the Office for their work, work other than "studying and improving the Office" (which is what my group does). Using our Office system from his home-site CRT terminal, a researcher in computer languages for instance could do the composing, modifying and studying associated with developing his research tools, with setting up and running tests, with integrating the results into his notes, and with communicating and publishing the results. 6a

His experimental programs and compilations may be run on the computer at his home site, or at other Network sites -- there will be means within the Office making it easy to interface to any special tools and data through the Network. The Office is the place where special attention is given to facilitating such supportive intellectual processes as formulating specifications for service requested and for how to present the results and where in the office's records to insert them; there are general needs in this regard over many activities, and the access to all of the special tools being developed in other computer-research areas will be very much heightened if they can be used from an "office" where a unified approach was taken to harnessing these tools. Examples: send your analytic formulation to MIT's Math Lab for processing; Utah's graphic-manipulation processes could construct your illustrations; and the ILLIAC IV can do your heavy computations. 6b

In this network, my group is slated to serve as the Network Information Center, which role offers new ways to experiment with collaborative dialogue. As we ourselves learn how to deal with it within our "conjoint office space", we expect to begin offering use of our "Dialogue Support System", through the Network, to people scattered over the country who want to do collaborative things in pursuit of Network activities. For instance, two graduate students from different universities could work closely together on a project, or a professor at one site could serve as a thesis advisor for a graduate student at another site. 6c

THE KNOWLEDGE MARKET 7

Here is a brief extrapolation into the future and its Augmented Individuals and Organizations, looking beyond both

the ARPA Network and my little experiments with an Augmented Office and a Dialogue Support System. Obviously there will be steadily widening distribution of common-resource accessibility, and a steadily increasing number of people who spend a significant amount of their professional time at terminals. The greater amount and diversity of mutually accessible resources -- human, financial, technological -- will accelerate growth along a number of dimensions. In particular, there will emerge a new "marketplace", representing fantastic wealth in commodities of knowledge, service, information, processing, storage, etc. In the number and range of transactions, and in the speed and flexibility with which they are negotiated, this new market will have a vitality and dynamism as much greater than today's as today's is greater than the village market. 7a

It seems apparent to me that, following this increased mutual accessibility between knowledge resources and consumers, will be the development of more "depth" in the range of both. E.g., just as with the roles of specialty shops and services in some of our industries today, there will be a large number of individuals and small groups each providing highly specialized services. Since their clientele will be drawn from such a large market, they will find a good business even where they serve only a small portion of the market and provide only seldom-needed special services. 7b

Let's look at a specific "for instance". Suppose that one person becomes extremely proficient in making small programs to generate a display or printout to show (particularly well) the status of a multi-task project. He is an independent agent in this multi-access computer network, working at a CRT console in his office at home. Perhaps he specializes in construction projects, and within this perhaps in steelwork erection. You are a management consultant working (from your home) on a short job helping to set up the production-control system for a construction project. When you realized that you might benefit from this kind of help, this is the sequence that takes place: 7c

Your man is easy enough to find because of computer help in searching for and evaluating special products and services. Suppose that you need something he can do for you with about 45 minutes' effort. You expect immediate accessibility for negotiation -- for instance: it takes you one minute to locate several candidates, two minutes to examine their relative credentials, 20 seconds interrogation of public records to select him as being available right now for your

kind of problem, two minutes of personal dialogue to determine for both of you that his capabilities and your needs match, and 15 seconds to negotiate and legalize a contract. He does his job in 40 minutes, and spends five more minutes transferring the results to you (with dialogue). 7d

He switches back immediately to a task sequence whose contract arrangement had permitted him such interruptions. In working on this job, you have been "time-shared" with several other jobs having higher priority, and several that were running "background". During the forty minutes he was off doing his thing for you, your higher-priority task sequences took you off on other pursuits. In fact, when he was done, you weren't ready to get back to him for twenty-three minutes, but the mutual-scheduling algorithm agreed upon in your contract took care of connecting you and him, when you were both ready, for your final dialogue. 7e

Your dialogue, of course, comprised both voice and shared computer graphics. Your mutually viewed display could be flipped back and forth between views of what he called forth on his end to show you, and what you provided to show him. As you were showing him your work domain, he was "catching" reference links into the specific items that he might later need to get at, entering quick notes on some of them. 7f

The whole dialogue was recorded, as a matter of course and for either of you to use later. The stored speech was digitized, and automatically segmented into the alternate passages of your exchange. During your dialogue, whenever one of you referred to a displayed item in your speech, your practice was to make an explicit screen-select action in association with the spoken reference term (e.g., with a "that line" or "both of these figures" expression), so that when any given passage might later be selected for "playback", the computer could re-create for you the image you were seeing and indicate the displayed entity being referenced. 7g

Some of the dialogue had stimulating and instructive contents for you. You wanted to save these and integrate them into your personal notes. Citations to this dialogue are easy to install in your notes, including citations to a speech passage -- where, upon later seeing such a citation and "calling for" the item it refers to, the associated bit string would be found and the speech passage played back for you. 7h

Perhaps you consider some of the speech passages to be useful enough to have them transcribed into text. A quick

designation of your desire causes these speech strings to be transmitted to a service you customarily use for doing your transcription. This service harnesses the latest speech-recognition computer aids, implemented with special-purpose hardware and software, and includes skilled clerical staff who supplement the 98% capability of the machine. Your two-minute transcription job is scheduled through their service units quite automatically, and the text strings are routed back and inserted in their appropriate places without your further attention. You have established the convention with the service agency that un-decipherable or dubious passages will be tagged, and if you had wanted to you could have designated when you sent the job off that you wanted to be interrupted to resolve such when the material returned. 7i

When you and your contractor parted ways, you each might exercise an optional procedure which helps you record your impressions of the other. An important part of your value within this marketplace rests upon your ability to integrate effectively the skills and knowledge of others. So you pay careful attention both to your "intelligence" base which helps you keep track of appropriate people, and to conducting your negotiations and working relationships with an eye for doing well by the other guy -- because he too probably keeps an effective intelligence system and it might well be important to you later that he (or his friends) feels good about working with you. You also need to assess his potential value to you for other and different collaboration. 7j

It is recognized rather widely that computer networks raise significant problems about the privacy of closed information. The other side of the coin is that computer networks raise rather remarkable opportunities to benefit from the sharing of open information. I am quite convinced that there is very high value to be derived within the Computer-Network Knowledge Market from a degree of openness with what have heretofore been considered as private types of information. 7k

Among the members of a working team, this could mean keeping open as a matter of course all of their scratch notes, trial designs, etc. to their colleagues, and expecting them to browse, comment, etc. Once this is the standard operating mode, those aspects of a person's vulnerability that depend mainly upon another's lack of understanding and compassion begin to find a compensating safeguard in the fact that hurtful actions taken therefrom by another person tend also to have complete visibility. This visibility, plus long-lasting

availability of notes and records, would be important to the processes by which each person evaluates his potential colleagues -- which soon becomes important to those concerned with personal growth within this market, and moves toward a lower significance otherwise hurtful actions attempted by those without mature concern for their own growth, or without ability to grow into or stay in a position where their comments and actions are trusted or seriously considered. 71

This may seem unduly naive, I know. But then consider an Afghanistanian villager, whose entire worldly experience is with a primitive every-man-for-himself market: what might it sound like to him to hear a peer suggest that the marketplace would benefit hugely by operating upon the basis of trusting the other man's word. "I say that I will pay you next week for a dozen buns, and I walk away without counting how many buns you put into the bag." Unreal fantasy -- talk of credit accounts, checking accounts, credit ratings, credit cards, etc. What does this have to do with getting the best price for my goat, to deal with abstractions such as accounts, promises to honor, reputation, etc. in a formalized, recorded fashion? Ludricous restrictions and dangerous vulnerability for a system to expect both me and my neighbor (adversary) to reveal our positions, stand behind the things we say and the marks we make, and depend upon the other to do so. 7m

It seems clear that today's Western-world economy couldn't be as strong as it is if such open vulnerability didn't prevail. I only wish that I knew the evolutionary dynamics that produced the attitudes and customs necessary to make the "honest openness" work -- obviously its practice in the Afghanistanian village would lead to disaster, and yet it likely was from just such a market environment that ours evolved. 7n

It seems not unreasonable to assume that survival value in our cultural evolution will favor institutions which support the most efficient Knowledge Markets (organisms which support the most efficient nervous systems). Then certainly the Knowledge Market will someday operate with more open trust in its knowledge interchange, to release for constructive ends a great deal of otherwise entrapped human energy. Those who grow up within such an environment will look back with pity upon the primitive fears and protective practices prevailing in 1970. 7o

SUMMARY 8

I think that tomorrow's institutions can be (must be) far better adapted to their environment, much better at providing for a full life style for everyone. These changes require a very significant increase in the institutions' ability to develop, support, and integrate the intellectual power of their individuals and organizations. And, as I see it, this ability will be directly dependent upon advanced application of interactive computers and multi-access computer networks. But the following condition is very strong in this "implications" picture: to harness this technology toward these ends will require intense concurrent development of our very complex and sophisticated system of concepts, conventions, methods, skills, organizational forms, attitudes, and values. It is time, and the means are at hand, to develop a much improved nervous system for our "social organisms". 8a

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